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FINAL PERFORMANCE REPORT

Time Period: April 1, 1999 through June 30, 2002

Project: Cooperative Agreement NCC2-1094 entitled "Analysis of Atmospheric Aerosol Data Sets and Application of Radiative Transfer Models to Compute Aerosol Effects"

Principal Investigator: Dr. Beat Schmid

Co-Principal Investigators: Drs. Robert W. Bergstrom and Jens Redemann

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1. Introduction

This report is the final report for the Cooperative Agreement NCC2-1094. It is a compilation of 29 peer-reviewed publications (published, in press or submitted) produced under this Cooperative Agreement and 30 first-authored conference presentations. The tasks outlined in the various proposals are listed below with a brief comment as to the research performed. Copies of title/abstract pages of peer-reviewed publications are attached.

2. NCC2-1094 Task and Accomplishments

A. "Derivation of a 1985-1995 Data Base on Stratospheric Aerosol Properties by Combining SAGE II and CLAES Measurements". Proposal funded by NASA.

This task represents the completion of Dr. Jill Bauman's PhD Thesis work at the State University of New York, Stonybrook entitled "*Information Retrieval Algorithm for Satellite Solar Occultation and Infrared Emission Measurements*". This also task resulted in three journal papers submitted recently and six conference presentations. Results in the dissertation and submitted mss describe a 15-year global stratospheric aerosol climatology derived from measurements by SAGE II and CLAES. At the Fall AGU meeting in 1999, Dr. Baumann also received the AGU Outstanding Student Paper Award. In July 2000, Dr. Baumann took on a civil service position in the Advanced Projects Branch at NASA Ames.

a) Peer-reviewed papers

Bauman, J. J., P. B. Russell, M. A. Geller, and P. Hamill, A Climatology of the Stratospheric Aerosol from SAGE II and CLAES Measurements I: Methodology, *J. Geophys. Res.*, submitted, 2002.

Bauman, J. J., P. B. Russell, M. A. Geller, and P. Hamill, A Climatology of the Stratospheric Aerosol from SAGE II and CLAES Measurements II: Results, *J. Geophys. Res.*, submitted, 2002.

Bauman, J. J., P. B. Russell, M. A. Geller, and P. Hamill, A Climatology of the Stratospheric Aerosol from SAGE II and CLAES Measurements, Part III: Comparisons *J. Geophys. Res.*, submitted, 2002.

b) Conference papers

Bauman, J.J., and P.B. Russell, Stratospheric Aerosol Climatology Derived from Satellite Solar Occultation and Infrared Emission Measurements, SPARC 2001 General Assembly, Paris France, November 2000.

Bauman, J.J., P. Hamill, and P.B. Russell, The Background Stratospheric Aerosol. EGS XXVI General Assembly, Nice France, March 2001.

Bauman, J.J., and P.B. Russell, 1984-1999 Global Stratospheric Aerosol. SPARC 2000 General Assembly, Mar del Plata, Argentina, November 2000.

Bauman, J.J., and P.B. Russell, Aerosol retrieval algorithm for satellite solar occultation and infrared emission measurements: Theory and 3-D analysis. *Chemistry and Radiation Changes in the Ozone Layer*, pp. 349-361, C. Zerefos Ed.. Kluwer Academic Publishers, 2000.

Bauman, J.J., and P.B. Russell, Volcanic Signatures in Estimates of Stratospheric Aerosol Size, Distribution Width, Surface Area and Volume Deduced from Global Satellite-Based Observations. Invited talk, Fall AGU Meeting, San Francisco CA, December 1999.

Bauman, J.J., and P.B. Russell, 1984-1995 Evolution of Stratospheric Aerosol Size, Surface Area, and Volume Derived by Combining SAGE II and CLAES Extinction Measurements. SAGE II Science Team Meeting, Hampton University, August 1999.

B. "Activities in SAGE III Science Team". Proposal funded by NASA.

This task resulted in one first-authored and four co-authored peer-reviewed journal articles and three first-authored conference papers by Dr. Schmid focusing on water vapor retrievals.

a) Peer-reviewed papers

- Schmid B.**, J.J. Michalsky, D.W. Slater, J.C. Barnard, R.N. Halthore, J.C. Liljegren, B.N. Holben, T.F. Eck, J.M. Livingston, P.B. Russell, T. Ingold, and I. Slutsker. Comparison of columnar water-vapor measurements from solar transmittance methods. *Applied Optics*, Vol. 40, No. 12, 1886-1896 (2001).
- Ingold, T., **B. Schmid**, et al., Modeled and empirical approaches for retrieving columnar water vapor from solar transmittance measurements in the 0.72, 0.82 and 0.94- μ m absorption bands. *J. Geophys. Res.*, 105(D19), 24327-24343, 2000.
- Kiedron P., J. Michalsky, **B. Schmid**, D. Slater, J. Berndt, L. Harrison, P. Racette, E. Westwater, and Y. Han, A Robust Retrieval of Water Vapor Column in Dry Arctic Conditions Using the Rotating Shadowband Spectroradiometer. *J. Geophys. Res.* 106(D20), 24007-24016, 2001.
- Pilewskie P., M. Rabette, R. Bergstrom, J. Marquez, **B. Schmid**, and P. B. Russell: The Discrepancy Between Measured and Modeled Downwelling Solar Irradiance at the Ground: Dependence on Water Vapor. *Geophys. Res. Lett.*, 27(1),137-140, 2000.
- Revercomb H.E., D.D. Turner, D.C. Tobin, R.O. Knuteson, W.F. Feltz, B. Balsley, J. Barnard, J. Bösenberg, S. Clough, D. Cook, R. Ferrare, J. Goldsmith, S. Gutman, R. Halthore, B. Lesht, J. Liljegren, H. Linné, J. Michalsky, V. Morris, W. Porch, S. Richardson, **B. Schmid**, M. Splitt, T. Van Hove, E. Westwater, and D. Whiteman. The Atmospheric Radiation Measurement (ARM) Program's Water Vapor Intensive Observation Periods: Overview, Accomplishments, and Future Challenges. *Bull. Amer. Meteor. Soc.* (submitted), 2001.

b) Conference papers (co-authored not listed)

- Schmid B.**, J. Michalsky, D. Slater, J. Barnard, R. Halthore, J. Liljegren, B. Holben, T. Eck, J. Livingston, and P. Russell. Comparison of columnar water vapor measurements during the fall 1997 ARM Intensive Observation Period: optical methods. Proceedings of the 10th ARM Program Science Team Meeting, San Antonio, Texas. March 13-17, 2000. Available online http://www.arm.gov/docs/documents/technical/conf_0003/schmid-b.pdf
- Schmid B.**, J. Michalsky, D. Slater, J. Barnard, R. Halthore, J. Liljegren, B. Holben, T. Eck, J. Livingston, and P. Russell. Comparison of columnar water vapor measurements during the fall 1997 ARM Intensive Observation Period: optical methods. 20th International Geoscience and Remote Sensing Symposium, Honolulu, Hawaii 24-28 July 2000.
- Schmid B.**, Eilers, J.A., McIntosh, D.M., Longo, K., Livingston, J.M., Redemann, J., Russell, P.B., Braun, J., and Rocken, C., Sunphotometric Measurement of Columnar H₂O and Aerosol Optical Depth During the 3rd Water Vapor IOP in Fall 2000 at the SGP ARM Site. Proceedings of the 11th ARM Program Science Team Meeting, Atlanta, Georgia. March 19 - 23, 2001.

C. “Improved Exploitation of Field Data Sets to Address Aerosol Radiative-Climatic Effects and Development of a Global Aerosol Climatology”. Proposal funded by NASA.

This task resulted in five first-authored and seven co-authored peer-reviewed journal articles and 16 first authored conference papers by Drs Bergstrom, Redemann and Schmid describing results from three major field campaigns TARFOX, ACE-2 and CLAMS.

a) Peer-reviewed papers

- Bergstrom, R. W.**, P. B. Russell, and P. Hignett, Wavelength dependence of the absorption of black carbon particles: Predictions and results from the TARFOX experiment and implications for the aerosol single scattering albedo, *J. Atmos. Sci.*, 59, 568-578, 2002.
- Redemann, J.**, R. P. Turco, K. N. Liou, P. B. Russell, **R. W. Bergstrom**, **B. Schmid**, J. M. Livingston, P. V. Hobbs, W. S. Hartley, S. Ismail, R. A. Ferrare, E. V. Browell, Retrieving the Vertical Structure of the Effective Aerosol Complex Index of Refraction From a Combination of Aerosol In Situ and Remote Sensing Measurements During TARFOX. *J. Geophys. Res.*, 105(D8), 9949-9970, 2000.
- Redemann, J.**, R.P. Turco, K.N. Liou, P.V. Hobbs, W.S. Hartley, **R.W. Bergstrom**, E.V. Browell, and P.B. Russell, Case studies of the vertical structure of the direct shortwave aerosol radiative forcing during TARFOX, *J. Geophys. Res.*, 105, 9971-9979, 2000.
- Redemann, J.**, P.B. Russell, and P. Hamill, Dependence of aerosol light absorption and single scattering albedo on ambient relative humidity for sulfate aerosols with black carbon cores, *J. Geophys. Res.*, 106, 27,485-27,495, 2001.
- Schmid, B.**, J. M. Livingston, P. B. Russell, P. A. Durkee, H. H. Jonsson, D. R. Collins, R. C. Flagan, J. H. Seinfeld, S. Gassó, D. A. Hegg, E. Öström, K. J. Noone, E. J. Welton, K. J. Voss, H. R. Gordon, P. Formenti, and M. O. Andreae, Clear sky closure studies of lower tropospheric aerosol and water vapor during ACE 2 using airborne sunphotometer, airborne in-situ, space-borne, and ground-based measurements, *Tellus*, B 52, 568-593, 2000.
- Ferrare, R., S. Ismail, E. Browell, V. Brackett, M. Clayton, S. Kooi, S. H. Melfi, D. Whiteman, G. Schwemmer, K. Evans, P. Russell, J. Livingston, **B. Schmid**, B. Holben, L. Remer, A. Smirnov, P. Hobbs. Comparisons of aerosol optical properties and water vapor among ground and airborne lidars and sun photometers during TARFOX. *J. Geophys. Res.*, 105(D8), 9917-9933, 2000.
- Collins, D. R., H. H. Jonsson, J. H. Seinfeld, R.C. Flagan, S. Gassó, D. A. Hegg, **B. Schmid**, P. B. Russell, J. M. Livingston, E. Öström, K. J. Noone, L. M. Russell, and J. P. Putaud, In situ aerosol size distributions and clear column radiative closure during ACE-2. *Tellus*, B 52, 498-525, 2000.
- Durkee, P. A., K. E. Nielsen, P. J. Smith, P. B. Russell, **B. Schmid**, J. M. Livingston, B. N. Holben, D. R. Collins, R. C. Flagan, J. H. Seinfeld, K. J. Noone, E. Öström, S. Gassó, D. A. Hegg, L. M. Russell, T. S. Bates, and P. K. Quinn. Regional aerosol properties from satellite observations: ACE-1, TARFOX and ACE-2 results. *Tellus*, B 52, 484-497, 2000.
- Gassó, S., D. A. Hegg, K. J. Noone, D. S. Covert, **B. Schmid**, P. B. Russell, J. M. Livingston, P. A. Durkee, and H. H. Jonsson, Influence of humidity on the aerosol scattering coefficient and its effect on the upwelling radiance during ACE2. *Tellus*, B 52, 546-567, 2000.
- Livingston, J. M., V. Kapustin, **B. Schmid**, P. B. Russell, P. K. Quinn, T. S. Bates, P. A. Durkee, P. J. Smith, V. Freudenthaler, D. S. Covert, S. Gassó, D. A. Hegg, D. R. Collins, R. C. Flagan, J. H. Seinfeld, V. Vitale, and C. Tomasi, Shipboard sunphotometer measurements of aerosol optical depth spectra and columnar water vapor during ACE 2 and comparison to selected land, ship, aircraft, and satellite measurements. *Tellus*, B 52, 594-619, 2000.
- Welton, E. J., K. J. Voss, H. R. Gordon, H. Maring, A. Smirnov, B. N. Holben, **B. Schmid**, J. M. Livingston, P. B. Russell, P. A. Durkee, P. Formenti, M. O. Andreae, and O. Dubovik, Ground-based

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- Russell, P. B., **J. Redemann**, **B. Schmid**, **R. W. Bergstrom**, J. M. Livingston, D. M. McIntosh, S. Hartley, P. V. Hobbs, P. K. Quinn, C. M. Carrico, M. J. Rood, E. Öström, K. J. Noone, W. von Hoyningen-Huene, and L. Remer, Comparison of aerosol single scattering albedos derived by diverse techniques in two North Atlantic experiments, *J. Atmos. Sci.*, 59, 609-619, 2002.
- b) Conference papers (co-authored not listed)*
- Bergstrom, R. W.**, and P. B. Russell. 1999. North Atlantic aerosol radiative effects based on satellite measurements and aerosol intensive properties from TARFOX and ACE 2, 18th Annual Conference, American Association for Aerosol Research, 11-15 October, Tacoma.
- Bergstrom, R. W.**, P. B. Russell, and H. Jonsson. 1999. Airborne solar radiant flux measurements during ACE 2. Eighteenth Annual Conference, American Association for Aerosol Research, 11-15 October, Tacoma.
- Bergstrom, R. W.** and P. B. Russell. 1999. North Atlantic aerosol radiative effects based on satellite measurements and aerosol intensive properties from TARFOX and ACE 2. IUGG99: XXII General Assembly of the International Union of Geodesy and Geophysics, July, Birmingham, ENGLAND.
- Redemann, J.**, P.B. Russell, R.P. Turco, **B. Schmid**, J.M. Livingston, R.W. Bergstrom, K.-N. Liou, R.F. Pueschel, E.V. Browell, P.A. Durkee, H.H. Jonsson, D.R. Collins, R.C. Flagan, J.H. Seinfeld, S. Gassó, E. Öström, K.J. Noone, E.J. Welton, K.J. Voss, H. R. Gordon, D.M. Powell, J.A. Reagan, Synthesis of Remote Sensing and In Situ Measurements of Dust Aerosol Events. *Workshop on Mineral Dust*, June 9-11, 1999, Boulder, CO.
- Redemann, J.**, P.B. Russell, P. Hamill. Measurements and Modeling of Aerosol Absorption and Single Scattering Albedo at Ambient Relative Humidity, Presented at the American Geophysical Union Fall Meeting, EOS Transactions, Vol. 80, no. 46, pp. 206, 1999.
- Redemann, J.**, P.B. Russell, **B. Schmid**, J.M. Livingston, **R.W. Bergstrom**, and D.M. McIntosh, Improved Exploitation of Field Data Sets to Address Aerosol Radiative-Climatic Effects and Development of a Global Aerosol Climatology - A progress report presented at the 3rd GACP science team meeting, NASA GACP science team meeting, Greenbelt, MD, October, 2000.
- Redemann, J.**, P.B. Russell, and P. Hamill, Dependence of aerosol light absorption and single scattering albedo on ambient relative humidity for sulfate aerosols with black carbon cores, Presented at the International Radiation Science (IRS) Meeting, St. Petersburg, Russia, July 2000.
- Redemann, J.**, P.B. Russell, M.P. McCormick, D.M. Winker, On the feasibility of studying shortwave aerosol radiative forcing of climate using dual-wavelength lidar-derived aerosol backscatter data, Presented at the 20th International Laser Radar Conference, Vichy, France, Proceedings, July 2000.
- Redemann, J.**, P.B. Russell. Lidar-aided Estimates of the Vertical Structure of the Direct Shortwave Aerosol Radiative Forcing of Climate, Presented at the Symposium on Lidar Atmospheric Monitoring - AMS Annual meeting, Long Beach, CA, *Proceedings*, 24-25, 2000.
- Redemann, J.**, **Schmid, B.**, Livingston, J. M., Russell, P. B., Eilers, J. A., Hobbs, P. V., Kahn, R., Smith, W. L., Holben, B. N., Rutledge, C. K., Pitts, M. C., Mishchenko, M. I., Chowdhary, J., Martins, J. V., Plana-Fattori, A., Charlock, T. P., Combining Suborbital Measurements of Aerosol Optical Depth and Columnar Water Vapor for Satellite Sensor Validations in the CLAMS (Chesapeake Lighthouse and Aircraft Measurements for Satellites) Experiment, 2001, *EOS Transactions*, Vol. 83, no. 19, pp. S22-23, 2002.
- Redemann, J**, **Schmid, B**, Livingston, J M, Russell, P B, Eilers, J A, Hobbs, P V, Kahn, R, Smith, W L, Holben, B N, Rutledge, C K, Pitts, M C, Mishchenko, M I, Chowdhary, J, Martins, J V, Plana-Fattori, A, Charlock, T P. Combining Suborbital Measurements of Aerosol Optical Depth and Columnar Water Vapor for Satellite Sensor Validations in the CLAMS (Chesapeake Lighthouse and Aircraft

- Measurements for Satellites) Experiment, 2001. *AGU 2002 Spring Meeting*, Washington, DC, 28 - 31 May 2002.
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- Schmid, B., Russell, P. B., J. M. Livingston, S. Gassó, D. Hegg, D. Collins, J. Seinfeld, E. Ostrom, K. Noone, P. Durkee, E. J. Welton, K. Voss, V. N. Kapustin, T. S. Bates, and P. K. Quinn**, Clear column closure studies of urban-marine and mineral-dust aerosols using aircraft, ship, satellite and ground-based measurements in ACE-2. Proceedings of the 10th Conference on Atmospheric Radiation of the American Meteorological Society, pp. 323-326, Madison, Wisconsin, 26 June-2 July 1999.
- Schmid, B., J. M. Livingston, P. B. Russell, P. A. Durkee, H. Jonsson, D. Collins, R. C. Flagan, J. Seinfeld, S. Gassó, D. A. Hegg, E. Ostrom, K. J. Noone, E. J. Welton, K. Voss, H. R. Gordon, P. Formenti, and M. O. Andreae**, Clear sky closure studies of lower tropospheric aerosol and water vapor during ACE 2 using airborne sunphotometer, airborne in-situ, space-borne, and ground-based measurements. Sixth Scientific Conference of the International Global Atmospheric Chemistry Project (IGAC) September 13-17, 1999, Bologna, Italy.
- Schmid B., D Collins, S Gassó, E Ostrom, D Powell, E Welton, P Durkee, J Livingston, P Russell, R Flagan, J Seinfeld, D Hegg, K Noone, K Voss, H Gordon, J Reagan, J Spinhirne**. Clear-sky Closure Studies of Tropospheric Aerosol and Water Vapor During ACE-2 Using Airborne Sunphotometer, Airborne in-situ, Space-borne, and Ground-based Measurements. EOS Trans. Amer. Geophys. Union, 80, F193, 1999.
- Schmid B., D. Collins, S. Gassó, E. Öström, D. Powell, E. Welton, P. Durkee, J. Livingston, P. Russell, R. Flagan, J. Seinfeld, D. Hegg, K. Noone, K. Voss, J. Reagan, J. Spinhirne**. Airborne sunphotometer, airborne in-situ, space-borne, and ground-based measurements of tropospheric aerosol in ACE-2. 20th International Geoscience and Remote Sensing Symposium, Honolulu, Hawaii 24-28 July 2000 (invited).

D. "Satellite-Sunphotometer Studies of Aerosol, Water Vapor and Ozone in Climate-Chemistry-Biosphere Interactions". Proposal funded by NASA.

This task resulted in two first-authored and six co-authored peer-reviewed journal articles and 4 first authored conference papers by Drs Bergstrom, Redemann and Schmid describing results from two major field campaigns SAFARI-2000 and PRIDE.

a) Peer-reviewed papers

Bergstrom, R.W., P. Pilewskie, **B. Schmid**, and P.B. Russell, Comparison of Measured and Predicted Aerosol Radiative Effects during SAFARI 2000, *J. Geophys. Res.*, submitted, 2002.

Schmid B., **J. Redemann**, P. B. Russell, P. V. Hobbs, D. L. Hlavka, M. J. McGill, B. N. Holben, E. J. Welton, J. Campbell, O. Torres, R. A. Kahn, D. J. Diner, M. C. Helmlinger, D. A. Chu, C. Robles Gonzalez, and G. de Leeuw, Coordinated airborne, spaceborne, and ground-based measurements of massive, thick aerosol layers during the dry season in Southern Africa, *J. Geophys. Res.*, in press, 2002.

Colarco P.R., O.B. Toon, J.R. Campbell, B.N. Holben, J.M. Livingston, P.B. Russell, H.B. Maring, D. Savoie, **J. Redemann**, **B. Schmid**, J.S. Reid, E.J. Welton, Saharan dust transport to the Caribbean during PRIDE: Part 2. Transport, vertical profiles, and deposition in simulations of in situ and remote sensing observations. *J. Geophys. Res.*, submitted, 2002.

Gatebe, C. K., M. D. King, S. Platnick, G. T. Arnold, E. F. Vermote, and **B. Schmid**, Airborne Spectral Measurements of Surface-Atmosphere Anisotropy for Several Surfaces and Ecosystem over Southern Africa, *J. Geophys. Res.*, submitted, 2002.

Livingston J. M., P. B. Russell, J. S. Reid, **J. Redemann**, **B. Schmid**, D. A. Allen, O. Torres, R. C. Levy, L. A. Remer, B. N. Holben, A. Smirnov, O. Dubovik, E. J. Welton, J. Campbell, S. A. Christopher, J. Wang, Airborne sunphotometer measurements of aerosol optical depth and columnar water vapor during the Puerto Rico Dust Experiment, and comparison with land, aircraft, and satellite measurements, *J. Geophys. Res.*, submitted, 2002.

McGill M., D. Hlavka, W. Hart, J. Spinhirne, S. Scott, and **B. Schmid**. The Cloud Physics Lidar: Instrument Description and Initial Measurement Results. *Applied Optics-LP*, Volume 41, Issue 18, 3725-3734, June 2002.

Magi, B. I., P. V. Hobbs, **B. Schmid**, and **J. Redemann**, Vertical profiles of light scattering, light absorption and single scattering albedo during the dry, biomass burning season in southern Africa and comparisons of in situ and remote sensing measurements of aerosol optical depths, *J. Geophys. Res.*, in press, 2002.

Pilewskie, P., J. Pommier, **R. Bergstrom**, W. Gore, M. Rabbette, S. Howard, **B. Schmid**, and P.V. Hobbs, Solar Spectral Radiative Forcing During the South African Regional Science Initiative, *J. Geophys. Res.*, in press, 2002.

b) Conference papers (co-authored not listed)

Redemann, J., P.B. Russell, J.M. Livingston, **B. Schmid**, J.S. Reid, and E.J. Welton, Airborne aerosol closure studies during the Puerto Rico Dust Experiment, Presented at the American Geophysical Union Fall Meeting, *EOS Transactions*, Vol.81, no. 48, pp.F43, 2000.

Schmid, B., P. B. Russell, P. Pilewskie, J. Redemann, J. M. Livingston, P. V. Hobbs, E. J. Welton, J. Campbell, B. N. Holben, M. McGill, Airborne sunphotometry and closure studies in SAFARI-2000 dry season campaign, 8th Scientific Assembly of IAMAS, Innsbruck, Austria, 10-18 July, 2001.

- Schmid B.**, P.B. Russell, P. Pilewskie, J. Redemann, P.V. Hobbs, E.J. Welton, J. Campbell, B.N. Holben, D.L. Hlavka, M. McGill, Airborne Sunphotometry and Closure Studies in the SAFARI-2000 Dry Season Campaign. First SAFARI-2000 Data Workshop, Siavonga, Zambia, 28-31 August, 2001.
- Schmid B.**, P. B. Russell, P. Pilewskie, J. Redemann, P. V. Hobbs, B. N. Holben, E. J. Welton, J. Campbell, D. L. Hlavka, M. McGill, A. Chu, L. A. Remer, O. Torres, R. Kahn, Coordinated airborne, space borne, and ground based measurements of massive, thick haze layers during the SAFARI-2000 Dry Season Campaign. AGU Fall Meeting 2001 San Francisco, CA.

E. “ACE-Asia Aerosol Radiative Effect Studies Using Airborne Sunphotometer, Satellite and In-Situ Measurements”. Proposal funded by NOAA, Office of Global Programs.

This task resulted in four first authored conference papers by Drs Bergstrom and Redemann describing results from the ACE-Asia field campaign.

a) Peer-reviewed papers

In preparation

b) Conference papers

Bergstrom, R. W., P. B. Russell, J. Redemann. 2001. Aerosol Radiative Forcing in the ACE Asia Region. Eighth Scientific Assembly of IAMAS, Innsbruck, Austria, 10-18 July.

Redemann J., B. Schmid, P.B. Russell, J.M. Livingston, J.A. Eilers, S.A. Ramirez, and R. Kahn. Airborne sunphotometry of aerosol optical depth and columnar water vapor during ACE-Asia. Presented at the Annual Meeting of the American Association for Aerosol Research, Portland, OR, October 15-19, Abstracts, pp. 443, 2001.

Redemann J., B. Schmid, P. Russell, J. Livingston, J. Eilers, R. Kolyer, S. Ramirez, R. Kahn, S. Masonis, T. Anderson, A. Clarke, S. Howell, C. McNaughton, C. Hsu. Towards a determination of aerosol radiative effects in the Pacific Basin troposphere based on aerosol extinction and optical depth closure studies aboard the NCAR C-130 in ACE-Asia. *ACE-Asia Data Workshop*, Oct. 29- Nov. 1, 2001 Pasadena, CA.

Redemann, J., B. Schmid, J. M. Livingston, P. B. Russell, J. A. Eilers, R. Kolyer, S. Ramirez, R. Kahn, N. C. Hsu, J. Wang, S. Masonis, T. Anderson, D. R. Collins, R. Flagan, J. H. Seinfeld, H. Jonsson, D. Hegg, D. S. Covert, A. Clark, S. Howell, and C. McNaughton, Airborne Sunphotometer Measurements of Aerosol Optical Depth and Water Vapor in ACE-Asia and their Comparisons to Correlative Measurements and Calculations, Abstracts, 11th Conference on Atmospheric Radiation, American Meteorological Society, Ogden, UT, June 3-7, pp. 35, 2002.

F. “Solar Spectral Flux, Optical depth, Water Vapor, and Ozone Measurements and Analyses in the Ace-Asia Spring 2001 Intensive Experiment”. Proposal funded by the Office of Naval Research.

This task resulted in one co-authored peer-reviewed journal article and one first authored conference paper by Dr Schmid describing results from the ACE-Asia field campaign.

a) Peer-reviewed papers

Wang J., R. C. Flagan, J. H. Seinfeld, H. H. Jonsson, D. R. Collins, P. B. Russell, **B. Schmid**, **J. Redemann**, J. M. Livingston, S. Gao, D. A. Hegg, E. J. Welton, and D. Bates. Clear-column radiative closure during ACE-Asia: Comparison of multiwavelength extinction derived from particle size and composition with results from sunphotometry, *J. Geophys. Res.*, submitted, 2002.

b) Conference papers

Schmid B., J. Redemann, J. Livingston, P. Russell, J. Eilers, D. Hegg, D. Covert, J. Wang, R. Flagan, J. Seinfeld, D. Collins, H. Jonsson, R. Kahn, C. Hsu, S. Ramirez, R. Bergstrom. Aerosol Optical Depth and Extinction Obtained from Airborne Sunphotometer, Airborne In-Situ (CIRPAS Twin Otter) and Spaceborne Measurements During ACE-Asia. *ACE-Asia Data Workshop*, Oct. 29- Nov. 1, 2001 Pasadena, CA

G. Invited Presentations

- Redemann, J.** Combining Remote Sensing and In Situ Aerosol Measurements for the Determination of Aerosol Optical Properties and Radiative Effects, Invited Presentation at Stanford University, February, 2000.
- Redemann, J.**, Remote Sensing of Aerosol Optical Properties and Radiative Climate Forcing, Invited Presentation at UCSB – Geography Department, January, 2000.
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- Schmid, B.**, “Tutorial on Airborne Sunphotometry and Closure Studies in the SAFARI-2000 Dry Season Campaign.” *First SAFARI-2000 Data Workshop*, Siavonga, Zambia, 28-31 August, 2001.
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Attachment A. Copies of title/abstract pages of peer-reviewed publications.